(19) **RU** (11) **2 195 946** (13) **C2**

(51) Int. Cl.$^7$ **A 61 K 35/60**

RUSSIAN AGENCY
FOR PATENTS AND TRADEMARKS

## (12) ABSTRACT OF INVENTION

(21), (22) Application: 99121332/14, 11.03.1998

(24) Effective date for property rights: 11.03.1998

(30) Priority: 11.03.1997 CA 2,199,694

(43) Application published: 20.07.2001

(46) Date of publication: 10.01.2003

(85) Commencement of national phase: 11.10.1999

(86) PCT application:
CA 98/00202 (11.03.1998)

(87) PCT publication:
WO 98/40088 (17.09.1998)

(98) Mail address:
129010, Moskva, ul. B.Spasskaja, 25, str.3,
OOO "Juridicheskaja firma Gorodisskij i Partnery", pat.pov. N.G.Lebedevoj

(71) Applicant:
LE LABORATORIZ AETERNA INK. (CA)

(72) Inventor: DJuPON Ehrik (CA)

(73) Proprietor:
LE LABORATORIZ AETERNA INK. (CA)

(74) Representative:
Egorova Galina Borisovna

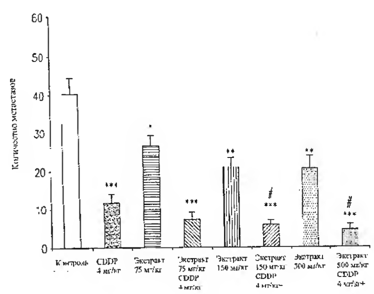
RU 2195946 C2

RU 2195946 C2

# (54) ANTITUMOR THERAPEUTIC PREPARATIONS INCLUDING THE COMBINATION OF CARTILAGINOUS EXTRACT AND THAT OF ANTINEOPLASTIC AGENT PROVIDING HIGH EFFICIENCY AT LOW TOXIC SIDE EFFECTS

(57) Abstract:

FIELD: medicine, pharmacology. SUBSTANCE: the innovation is described to use a liquid cartilaginous extract containing the molecules of up to 500 kDa molecular weight as a preparation to protect a patient against toxic side effects as a result of antineoplastic agents injected. Cartilaginous extract could be used in the content of either pharmaceutical composition or therapeutic kit containing an antineoplastic agent. EFFECT: combined therapy provides higher efficiency of antitumor action due to decreased number of toxic side effects. 6 cl, 3 dwg, 4 tbl



Фиг. 1

This invention relates to anti-tumor therapies which comprises anti-neoplastic agents and a cartilage extract having anti-tumor activity.

## BACKGROUND OF THE INVENTION

Present assignee already described the biological activities recovered from cartilage tissue, namely from shark cartilage. The processes of obtention of cartilage extracts and the properties of the extracts themselves are disclosed in international publications WO 95/32722, WO 96/23512 and WO 97/16197. The processes generally comprise the steps of: homogenizing and extracting shark cartilage until a mixture of cartilage particles of an average size of about 500 pm and a crude liquid extract are obtained, separating said particles from said crude liquid extract, and fractionating said crude liquid extract so as to recover molecules having a molecular weight lower than about 500 KDa. These processes apply to the extraction of biological activities from any source of cartilage.

Shark cartilage liquid extracts have been tested in various assays and they comprise anti-angiogenic, anti-collagenolytic, direct anti-tumor proliferating and anti inflammatory activities.

These cartilage extracts are described as being efficient against tumors and nevertheless innocuous since no serious adverse effect directly related to their oral administration has been observed in treated animals and human patients. The shark cartilage liquid extract and any other cartilage extract having equivalent anti-tumor activities are all within the scope of this invention and will be referred to as "cartilage extracts."

A large panel of therapeutic agents is known for treating cancer. Antineoplastics include, but are not limited to, the following substances:

TABLE 1

Alkylating Agents
Alkyl Sulphonates: busulfan
Ethylene Imines:thiotepa
Nitrogen Mustard Analogues: chlorambucil, cyclophosphamide, estramustine sodium phosphate, ifosfamide, mechlorethamine hydrochlorid, and melphalan.
Nitrosourea Derivatives: carmustine, lomustine, streptozocin
Platinum-containing Compounds: carboplatin, cisplatin
Antimetabolites
Folic Acid Analogues: methotrexate sodium
Purine Analogues: cladribine, mercaptopurine, thioguanine
Pyrimidine Analogues: cytarabine, fluorouracil
Urea Derivatives:hydroxyurea
Cytotoxic Antibiotics
Anthracyclines: daunorubicin, doxorubicin hydrochloride, epirubicin hydrochloride, idarubicin hydrochloride
Actinomycins: dactinomycin
Various Cytotoxic Antibiotics: bleomycin sulfate, mitomycin, mitotane, mitoxantrone

hydrochloride
Plant Alkaloids and other Natural Products
Epipodphyllotoxins: etoposide, teniposide
Taxanes: docetaxel, paclitaxei
Vinca Alkaloids and Analogues: vinblastine sulfate, vincristine sulfate, vindesine sulfate, vinorelbine tartrate
Various Anti-tumor substances: altretamine, amsacrine, 1-asparaginase, dacarbazine, fludarabine phosphate, porfimer sodium, procarbazine hydrochloride, tretinoin (all-trans retinoic acid) with systemic introduction
Anti-angiogenics: Marimastat, Suramin, TNP 470, Thalidomide, and Radiotherapeutics

Most of these anti-neoplastics or anti-tumor agents have a low safety margin since they are highly toxic, e.g. they provide severe undesirable effects at effective dosages.

It is an accepted fact, in the medical field, that no anti-tumor therapy is perfect.

Pharmacologists and oncologists always have to deal with a compromise between a maximally effective dose and the toxic side effects thereof. As a result, an effective dose of a neoplastic may be given in a sub-maximal dose to avoid too severe toxic side effects to any possible extent. So, avoidance of severe toxic side effects unfortunately often has the priority of concern over maximal efficacy.

The cartilage extracts that we already described (op. cit.) are active in vivo against tumor proliferation, which activity appears to be due to a combination of at least a direct anti-tumor activity, anti-collagenolytic and anti-angiogenic activities. This extract has a well-proven anti-tumor activity and is devoid of toxic side effects. Since the current studies in the field aim at obtaining an anti-tumor therapy which would have close to 100% efficacy with close to 0% toxicity, it will be readily appreciated that antitumor compositions approaching these gold standards would be greatly welcome.

There is therefore a need for anti-neoplastic therapies combining high antitumor efficacy and low toxic side effects.

## SUMMARY OF THE INVENTION

There is now provided improved anti-tumor therapies comprising administering an effective anti-tumor amount of an anti-neoplastic agent and an effective anti-tumor amount of a cartilage extract.

The overall advantageous contribution of the cartilage extract is addition to the efficacy of the anti-neoplastic and protection against toxic side effects.

It is therefore an object of the present invention to provide a use of a cartilage extract having anti-tumor activity in a combined anti-tumor therapy, to increase anti tumor activity of an anti-neoplastic in a patient who is administered an anti-tumor amount of that anti-neoplastic and to protect the patient against an increase of toxic side effects inherent to the administration of the anti-neoplastic.

Combined anti-tumor therapy may take two forms: 1) administering to the patient a composition of an anti-neoplastic and a cartilage extract, and 2) administering to the patient an anti-neoplastic and a cartilage extract, separately, in a timeoverlapping or

simultaneous fashion (generally defined as "concurrent treatment").

In a specific embodiment, the cartilage extract is a shark cartilage extract obtained by a process comprising the steps of: homogenizing and extracting shark cartilage until a mixture of cartilage particles of an average size of about 500 pm and a crude liquid extract are obtained, separating said particles from said crude liquid extract, and fractionating said crude liquid extract so as to recover molecules having a molecular weight lower than about 500 KDa.

In a first preferred embodiment, the anti-tumor amount of the anti-neoplastic is a sub-optimal dose thereof, and the amount of cartilage extract given in combination adds anti-tumor efficacy to the anti-neoplastic with no increase, even better a decrease, of toxic side effects inherent to the administration of higher dose of the antineoplastic which would have an anti-tumor efficacy equivalent to the combined antitumor therapy.

In a second preferred embodiment, the anti-tumor amount of the anti-neoplastic is an optimal dose thereof, and the amount of cartilage extract given in combination adds anti-tumor efficacy to the anti-neoplastic with no increase, even better a decrease, of toxic side effects inherent to an administration of said anti-neoplastic.

The choice of a sub-optimal or optimal dose of an anti-neoplastic merely depends on the aggressivity sought for a treatment and the severity of the side effects of the anti-neoplastic.

The anti-neoplastic may be busulfan, thiotepa, chlorambucil, cyclophosphamide, estramustine sodium phosphate, ifosfamide, mechlorethamine hydrochloride, melphalan, carmustine, lomustine, streptozocin, carboplatin, cisplatin, methotrexate sodium, cladribine, mercaptopurine, thioguanine, cytarabine, fluorouracil, hydroxyurea, daunorubicin, doxorubicin hydrochloride, epirubicin hydrochloride, idarubicin hydrochloride, dactinomycin, bleomycin sulfate, mitomycin, mitotane, mitoxantrone hydrochloride, etoposide, teniposide, docetaxel, paclitaxel, vinblastine sulfate, vincristine sulfate, vindesine sulfate, vinorelbine tartrate, altretamine, amsacrine, l-asparaginase, dacarbazine, fludarabine phosphate, porfimer sodium, procarbazine hydrochloride, tretinoin (all-trans retinoic acid), marimastat, suramin,
TNP 470, thalidomide or radiotherapy.

In a specific embodiment of the invention, the anti-neoplastic is cisplatin.

It is another object of this invention to provide products which may be used for bringing into practice the novel use for a cartilage extract.

One of the products is an anti-tumor composition comprising an anti-tumor amount of an anti-neoplastic and an anti-tumor amount of a cartilage extract, in a suitable pharmaceutically acceptable carrier.

Another one of these products is an anti-tumor treatment kit comprising a first component consisting of an anti-neoplastic in an anti-tumor dosage form and a second component consisting of a cartilage extract in an anti-tumor dosage form.

## DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

We have tested combined anti-tumor therapies comprising administering a cartilage

extract and an anti-neoplastic, hoping to find out if the efficacy of each other may be improved without any increase, or better with a decrease, of toxic side effects.

This invention will be described by way of preferred embodiments and with further reference to the following appended Figures, which purpose is to illustrate the invention rather than to limit its scope.

BRIEF DESCRIPTION OF FIGURES

Figure 1 shows the reduction in the number of metastases in LLC mouse tumor model. Increasing doses of cartilage liquid extract (/E-X) have been orally administered to LLC mice alone or in combination with cisplatin (CDDP). CDDP alone has also been tested alone. The control represents saline-treated mice.

Figure 2 shows the variations of body weights of LLC mice treated with cisplatin (CDDP), increasing amounts of cartilage liquid extract ( -X), alone or in combination, compared with saline-treated animals (control).

Figure 3 shows the correlation between the white blood cell counts and the stringency of anti-tumor treatment with regard to toxicity.

RESULTS

We have characterized some ingredients from our proprietary shark cartilage liquid extract (op.cit.) and we have found the presence, amongst others, of hypoxanthine, its furanoside derivative, and dimers, in a total concentration of about 75 mkg/20 mg of dry weight of total cartilage liquid extract. This amount of hypoxanthine should not be toxic in vivo although it is not excluded that it may be effective against tumors.

Hypoxanthine is a substrate for the enzyme hypoxanthine-guanine phosphoribosyl transferase (HGPRT), a purine salvaging enzyme (Weber et al.; 1983).

Hypoxanthine forms inosine monophosphate, which is a key intermediate shared for production of adenylates and guanylates. Although hypoxanthine may ultimately lead to an increase of the incorporation of purine bases into nucleotides and nucleic acids, which would favorize DNA synthesis, many cellular systems make use of purines in various cellular pathways, some of which are activators while others are inhibitory. It is known that hypoxanthine has an in vitro anti-proliferative activity against tumor cells, which suggests that inhibitory pathways involving hypoxanthine may have precedence over activator ones in cancer cells.

In human subjects, anecdotal data show that the patients concurrently treated with the cartilage extract and radiotherapy or chemotherapy have recovered more rapidly and the general appearance and health of there nails and hair improve significantly. On the other hand, those patients taking only the cartilage extract have also seen their general health improving while cancer is regressing. These observations indicate that the cartilage extract is not only efficient by itself in tumor proliferation regression, but also that it counteracts and/or permits more rapid recovery from adverse effects of other anti-cancer therapies.

We have verified the in vivo anti-tumor activity of cartilage extract in two animal models:

- DA3 mice, which tumors have a low metastatic potential; and
- LLC mice, which tumors are highly metastatic.

DA3 model:
The anti-tumor potential of cartilage extract was studied in a mouse mammary adenocarcinoma model (allograft). DA3 cells (1 X $10^6$) were inoculated subcutaneously into the right flank of adult BALB/c mice. These cells originate from a murine mammary adenocarcinoma induced by 7,12-dimethylbenzanthracene (DMBA). DA3 is a non- or low-metastatic murine mammary carcinoma (D. Medina, J. Natl. Cancer Inst., 1969, 42: 303-310; ibid., 1976, 57:1185-1189). Inoculated cells grow slowly in vivo and form a solid tumor with a low metastatic prognosis. DA3 cells were maintained in RPMI 1640 medium supplemented with 50 µm mercaptoethanol, 0.2 mM Hepes buffer solution, 1 mM Na-pyruvate, 2 mM L-glutamine, 0.1 mM non-essential amino acids, 10 mM vitamins, 10% fetal bovine serum and 1% penicillin streptomycin. The cells were incubated at 37°C in atmosphere containing 5% $CO_2$. Under these conditions, DA3 cells proliferate but do not differentiate. For tumor induction, cells were grown to 70% confluence in complete medium and then collected using trypsin-EDTA solution Cells were centrifuged, washed three times with phosphate buffer solution (D-PBS, Ca++ and Mg++ free), and resuspended at a dilution of 1 x $10^7$ cells/ml. Mice (n = 15) were inoculated with 0.1 ml of cell suspension and were given daily oral administration of cartilage extract or a placebo (saline solution). The treatments began the day of DA3 cell inoculation or 7 days later, after randomization of animals. Various concentrations of cartilage extract were tested. Cartilage extract dose levels are expressed as the amount of cartilage extract dry weight administered per kg of body weight.

Tumor growth was monitored every third day. Tumor length and width were measured and the relative tumor volume ($cm^3$) calculated as follows (Length (cm) x width2 ($cm^2$)/2). Mice were sacrificed on the 54th days after tumor inoculation, at which time tumors were removed and weighed.

When doses of 100 to 400 mg/Kg of cartilage extract (dry weights) were daily administered to DA3 mice, a reduction of more 50% of tumor size after 48 days of treatment was observed (data not shown).

LLC Model:
We have verified the anti-tumor efficacy and the protective effect of cartilage extract by testing a combination of diverse concentrations of cartilage liquid extract alone and in combination with cisplatin (CDDP), in the Lewis lung carcinoma model (LLC).

LLC cells were resuspended in sterile PBS ($10^6$ cells/0.2 ml) and implanted in C57B1/6 mice. After a period of 11 days, primary tumors reached an average volume of 1.0 $cm^3$ and were surgically resected. After surgery, mice were randomized into groups of 15 animals and control article (saline) and cartilage extract were administered on a daily basis via oral gavage at the dose levels indicated for a period of 15 days. At day 16-post-surgery, animals were sacrificed, the lungs fixed in 10% formamide and the number of lung metastases counted. Animals were always kept under controlled environment: temperature 22°C, humidity 40% to 50%, light/dark cycle: 12 hours. They were fed and given to drink ad libitum.

In a first experiment, five injections of CDDP were given intraperitoneally every three days (1, 2 and 3 mg/Kg). Cartilage extract was given per os daily (31,125 and 500 mg/Kg). Saline was given as a control. Results are summarized in Table 2.

TABLE 2
EMI9.1

| CCDP (mg/kg) | Percent reduction from control | | | |
|---|---|---|---|---|
| 3 | 54 | 60 | 69 | 85 |
| 2 | 35 | 46 | 69 | 73 |
| 1 | 19 | 39 | 69 | 65 |
| 0 | 0 | 23 | 65 | 69 |
| | 0 | 31 | 125 | 500 |

Cartilage extract (mg/Kg)
It was observed that cartilage extract showed neither synergy nor antagonism but was additive in its ability to reduce LLC lung metastasis. CDDP alone at 3 mg/Kg provided 54% metastases reduction, while cartilage extract alone at 125 and 500 mg/Kg provided 65% and 69% reduction, respectively. The resulting decrease (85%) in metastases seen at the combination of the highest dose (500 mg/Kg/day) of cartilage extract and CDDP (3 mg) was equivalent to the one observed with CDDP alone at 5 mg/Kg, but without the toxicity observed at that higher dose of CDDP (data not shown). Thus, the addition of cartilage extract to a sub-optimal, low toxicity level dose of CDDP resulted in the maintenance of anti-metastatic activity usually observed at higher doses of CDDP.

In a second independent experiment, CDDP was given at a dose of 4 mg/Kg.

Cartilage extract was given at doses 75,150 and 500 mg/Kg. Saline was given again as a control. The results on the reduction of number of metastases are summarized in Figure 1. Administration of CDDP alone reduced the number of metastases by about 71%.

Cartilage extract was effective in reducing the number of metastases at all tested doses. Maximal effect on metastase reduction occurs at the dose of 150 mg/Kg or higher.

The combination of the two highest doses of cartilage extract (150 and 500 mg/Kg) and CDDP provide a supra-maximal effect (85% - 87%) when compared to the maximal effect observed with an optimal dose of CDDP alone (about 71%).

The toxic side effects were evaluated by measuring the body weights. The results are illustrated in Figure 2.

During the first week of treatment, the body weights increased in all groups.

Treatment started on Day 12 of the protocol. The decrease in body weight observed between the second and the third time point of the graph results from the surgery (on day 11) necessary to remove the primary LLC tumor mass. After fifteen days from inoculation, it was observed that CDDP alone was very toxic since a decrease of about 16% of body weight occurred in comparison to the non-treated group.

Cartilage extract alone, at all doses, did not affect the body weight decrease, while efficacious in the reduction of lung metastase numbers. When combined with CDDP, cartilage extract exerts a protective effect by reducing the loss of body weight triggered by CDDP (doses of 75,150 and 500 mg/Kg cartilage liquid extract compared to CDDP; $p < .05$ for the overall treatment period).

An overall dose of about 150 - 500 mg of cartilage extract can be combined to 3 - 4 mg CDDP to achieve supra-maximal effect with no increase of toxicity, even at the highest dose of CDDP.

Toxicity was evaluated in cancerous animals by the body weight decrease. We further characterized the nature of the protective effect provided by the cartilage extract by assessing an hematology parameter namely the number of peripheral white blood cells. Normal mice were injected (I.P.) with CDDP (3 and 4 mg/kg) on days 1, 4,7,10 and 13 of the experimental protocol. The cartilage extract was administered, orally, at doses of 75,150 50 and 500 mg/kg/day. Animals were sacrificed on day 15 and blood samples were collected for cell count using an automated blood cell analyzer.

Groups consisted of animals receiving CDDP alone, the cartilage extract alone, both in combination or saline as negative control.

Administration of CDDP resulted in a significant decrease of the number of white blood cells (Tables 3 and 4). Co-administration of the cartilage extract to CDDP protected against the reduction of the white blood cells (cartilage vs 3 mg/kg CDDP, $p < 0.05$; cartilage vs 4 mg/kg CDDP, $p < 0.01$). Values obtained from individual groups that have received cartilage extract were pooled to increase statistical power. Mean white blood cell counts were plotted according to treatment group regimen (Figure 3).

A linear trend indicated a clear monotonic trend ($r2 = 0.9126$) for as decrease in cell counts according to treatment regimen stringency. This observation is in agreement with a protective effect of the cartilage extract relative to the peripheral white blood cell population reduced during CDDP administration.

TABLE 3

| Number of white blood cells ($\times 10^9$/l) | | | | | | |
|---|---|---|---|---|---|---|
| Group Number | #1 | #2 | #3 | #4 | #5 | #6 |
| Treatment | Control | Æ-X (75–500 mg/kg) | CDDP (3 mg/kg) | CDDP (4 mg/kg) | Æ-X (75–500 mg/kg) + CDDP (3 mg/kg) | Æ-X (75–500 500 mg/kg) + CDDP (4 mg/kg) |
| Number of white blood cells | 6.1 | 6.0 | 3.4 | 3.3 | 4.0 | 4.6 |
| N | 4 | 11 | 8 | 8 | 16 | 16 |

TABLE 4 Number of white blood cells ( x 109/l)
EMI11.1

| Control | Value of P |
|---|---|
| Group 1 relative to all others | 0.0045 |
| Group 3 relative to Groups 5 and 2 | 0.0233 |
| Group 4 relative to Groups65 and 2 | 0.0015 |

Based on the biological activities demonstrated for the cartilage extract, it is now contemplated that cartilage extract may be used for complementing a large variety of antineoplastics. Combinations of known anti-neoplastics with cartilage extract will provide the great advantage of being highly efficacious and with no increase or even lower toxicity than an effective amount of the neoplastics used alone. We therefore provide a method for treating tumors, which comprises the steps of administering a combination of an antitumor amount of cartilage extract and an anti-tumor amount of an anti-neoplastic, whereby said combination provides for high efficacy and decreased side effects due to said anti-neoplastics. The anti-neoplastics are not limited to cisplatin.

Indeed, those of
Table 1 are all good candidate examples for the combinations of this invention.

The decreased toxic side effects comprises: hair and nail health improvement, diminution of nausea, gain of appetite and body weight, diminution of bone marrow depression, diminution of white blood cell counts decrease and a general diminution of morbidity and mortality.

This invention has been described hereinabove, with reference to specific embodiments. It is well within the ability of the skilled artisan to make modifications without departing from the above teachings. These modifications are within the scope of this invention as defined in the appended claims.